IJSPT

CASE REPORT

CLINICAL REASONING IN THE FACE OF UNCERTAINTY: CONSERVATIVE PHYSICAL THERAPY MANAGEMENT OF A TEENAGE ATHLETE DIAGNOSED WITH A PROXIMAL HUMERAL NON-OSSIFYING FIBROMA

Timothy J. Reynolds, PT, DPT, OCS, CSCS[1]
Joseph Paul Coviello, PT, DPT[2]
Michael Costello, PT, DSc, OCS, MTC[3]

ABSTRACT

Background and Purpose: There have been few published studies regarding the treatment of patients with non-ossifying fibromas (NOFs), either conservatively or operatively. The purpose of this case report is to discuss the clinical presentation and conservative management of a teenage athlete diagnosed with a proximal humerus NOF.

Case Description: The subject was a 13-year-old male middle school student with a diagnosis of left shoulder pain over the prior year preventing him from participating in sports activities. The combination of radiological findings revealing a NOF and a thorough physical examination allowed for the development of a physical therapy plan of care to address impairments and functional limitations. The subject was seen for eight visits where a combination of manual therapy techniques, neural mobilizations, and therapeutic exercises were administered to the cervical and upper quarter regions. The subject's progress was tracked by measuring pain-free shoulder active range of motion (AROM) and monitoring changes using the Numerical Pain Rating Scale (NRPS) values throughout sessions.

Outcomes: After four sessions, AROM shoulder flexion and abduction increased from 123º and 119º to 160º and 180º respectively, and worst NRPS decreased from 9/10 to 3/10. Upon discharge after the eighth visit, the subject's DASH improved from 11.66 to 2.5. The subject remained pain free at an eight month follow up and returned to activity.

Discussion: Thorough assessment of both neuromechanical sensitivity and musculoskeletal impairments may provide for the utilization of conservative treatment options for individuals with symptomatic NOFs.

Level of Evidence: 4

Keywords: neural mobilizations, non-ossifying fibroma, shoulder, movement system

[1] Cayuga Medical Center, Ithaca, NY, USA
[2] Summit Physical Therapy, Summit, NJ, USA
[3] Ithaca College, Ithaca, NY, USA

COI statement:

CORRESPONDING AUTHOR
Timothy J. Reynolds
11 Rowe Rd
Red Hook, NY 12571
Phone: (845) 214-7801
E-mail: treynolds@cayugamed.org

DOI: 10.26603/ijspt20181049

BACKGROUND AND PURPOSE

Non-ossifying fibromas (NOFs) are benign, lytic bone lesions located within the metaphyseal region of long bones that extend into the medullary canal.[1] This tumor differentiates itself from a focal cortical defect (FCD) based on the size and location of the lesion, requiring a length greater than 3 cm with some portion of the tumor being found within the medullary canal to be classified as a NOF.[2] NOFs are more commonly seen in younger individuals, as it has been documented that upwards of 75% of NOFs occur within the second decade of life, but also may be common between the first and third decades.[3,4] Males tend to have a higher incidence rate than females, and Abdelsayed et al. reported the prevalence of fibrous defects in cortices of long bones was greater than 35% in children.[1,5] While NOFs can be found in most long bones, they are frequently found about the knee joint, most commonly at the distal femoral metaphyses, followed by the distal tibial metaphyses.[1,4] Another well documented location is the mandible, but a case report regarding a NOF identified in a child's mandible found that only 10 isolated NOFs of the jaw have been reported since 1964.[6]

The majority of NOFs are asymptomatic, but larger tumors may result in discomfort or potential pathological fractures.[2] Arata et al. found that if NOFs involve more than 50% of the transverse diameter of the bone or measure more than 33 mm in length, there is an increased risk of pathological fracture.[7] This finding has come into question recently as a more recent case series showed that 59% of cases of NOF exceeded these threshold measurements without fracturing.[8]

There have been few published studies regarding the treatment of NOFs, either conservatively or operatively. Regarding a NOF of the mandible, Bailey et al. stated that curettage and resections were the primary form of treatment for symptomatic patients.[6] Another group of authors who studied curettage and grafting in athletes with benign bone lesions found positive results and return to play in patients undergoing the respective procedures.[3] While there have been several studies regarding surgical procedures and the management of patients with NOFs, there are limited published reports regarding conservative treatment of patients diagnosed with NOFs. The purpose of this case report is to discuss the clinical presentation and conservative management of a teenage athlete diagnosed with a proximal humerus NOF.

CASE DESCRIPTION: SUBJECT HISTORY AND SYSTEMS REVIEW.

A 13-year-old male middle school student was referred to physical therapy by an orthopedic specialist with a diagnosis of left shoulder pain. The subject reported an insidious onset of left shoulder pain over the past year, unchanged by positioning of the arm or with medications. He did not recall a specific injury that precipitated his symptoms, although he noted an increase in burning and tingling symptoms throughout the upper arm after he was pushed into the bleachers while playing floor hockey several weeks prior, striking his lateral shoulder. The subject stated that his symptoms radiated distally down his left arm to the level of the elbow intermittently, but were primarily isolated to the anterior shoulder. In addition to the pain, his primary complaints included significantly decreased range of motion and strength, limiting his ability to participate in extracurricular activities such as playing football, basketball, skeet shooting, and participating in physical education class. The subject's goals were to decrease pain, increase shoulder mobility, and return to the above-mentioned sport activities which were limited secondary to pain.

Information from the medical history questionnaire was used to initially screen for potential red flags that would suggest a serious underlying pathology that would necessitate referral. With regard to past medical history, the subject reported having sustained previous clavicle and elbow fractures three years prior (both on the left side), severe migraines, as well as a history of a non-ossifying fibroma located within the proximal humerus.

The Numeric Pain Rating Scale (NPRS) was used to measure pain intensity. The subject rated *average pain*, *least pain*, and *worst pain* over the last 24 hours on a 0 to 10 scale, 0 representing no pain and 10 representing the worst pain imaginable. The subject rated his pain as 6-6-9 (least, average, worst pain, respectively), the mean of these three scores was 7.0. The NPRS has demonstrated acceptable levels of

reliability and validity[9-11] and a two-point change in the NPRS has been reported to be clinically meaningful.[12] The Patient-Specific Functional Scale (PSFS) is a self-report measure that was used to measure the subject's perceived level of disability.[13] The subject is asked to choose and rate three activities that are difficult due to the subject's condition, each on a 0 to 10 scale, with 0 representing inability to perform the activity and 10 representing the ability to perform the activity as well as he or she could prior to the onset of symptoms. The minimally clinically important change is two points.[13] The subject in this case report only chose two activities, and rated playing basketball and skeet shooting as 6/10 and 5/10 respectively. The subject also completed the Disabilities of Arm, Shoulder, and Hand (DASH) questionnaire (ICC = .90), which has been found to be a valid subject reported outcome measure for individuals with upper extremity pathologies.[14] The subject scored 11.66 on the DASH and a 25 on the DASH sports module.

CLINICAL IMPRESSION #1

The subject's initial symptoms were insidious in onset over the course of one year, although he reported an exacerbation in symptoms after striking his lateral shoulder against the bleachers while playing hockey. Differential diagnosis consists of a deltoid strain, rotator cuff strain, rotator cuff tear, subacromial impingement syndrome, acromioclavicular joint sprain, proximal physeal fracture, and cervical radiculopathy. Because MRA imaging ordered by the physician revealed a non-ossifying fibroma located in the proximity of where the subject reported having pain, this was also considered in the differential diagnosis list. The examination included screening for cervical radiculopathy as a possible cause followed by examination including strength, flexibility, palpation, and special testing of the shoulder complex to further discern the underlying causes as well as the functional presentation and movement diagnosis.

EXAMINATION

The subject did have imaging performed which indicated the following plain radiographs that revealed no acute fracture or dislocation, however did reveal an eccentric area of rarefaction in the medial metadiaphysis of the left proximal humerus with a sharp zone of transition. Subsequently, a MRA was performed revealing "a 3.1 cm cephalocaudal expansile sharply circumscribed lesion in the medial cortex of the proximal metaphysis diaphysis of the humerus corresponding with the plain film findings consistent with a benign non-ossifying fibroma." (Figures 1-2)

Figure 1. *Axial view of shoulder MRA revealing a benign non-ossifying fibroma.*

Figure 2. *Axial view of shoulder x-ray.*

Postural observation of the subject revealed bilateral forward shoulder posture with slight forward head posturing, and anterior tilting of both scapulae at rest.[15] Due to the subject's subjective reports of "burning and tingling" in the shoulder that occasionally radiated down the arm, a cervical screen including active range of motion and Spurling's Tests were performed without any reproduction or exacerbation of the subject's symptoms. Observation of gross glenohumeral motion revealed marked limitations in all planes due to pain. Scapular dyskinesis was demonstrated as an inability to control scapular internal rotation upon eccentric return from a flexed and abducted position, as well as marked forward head posturing during both overhead movements. Active range of motion measurements were performed using a standard goniometer with the subject able to reach 123º of shoulder flexion and 119º of shoulder abduction. Internal rotation was examined using the Apley Scratch Test, and the subject was able to reach one inch inferior to the inferior scapular angle. All active ranges of motion were limited secondary to reports of pain. The subject experienced hypoesthesia to light touch within C4 and C5 dermatomes on the left side, but no other abnormalities to sensation were noted.

The subject reported pain with both Hawkins-Kennedy and Empty Can tests, and had a negative Drop Arm Test.[16] Passive shoulder mobility was not tolerated by the subject as he was apprehensive towards any shoulder movements, and reported pain upon testing all planes.

Due to the subject's subjective history which included intermittent sensations of burning and tingling that radiated from his shoulder to his elbow, further evaluation of neuromechanical sensitivity was warranted. Since the subject was unable to tolerate passive shoulder testing, this also prevented the examiner from assessing neurodynamics, particularly the Upper Limb Neural Tension Test A at initial examination. The subject also reported significant discomfort when assessing glenohumeral joint mobility; therefore, a thorough assessment of joint play was unable to be performed, and due to the subject's level of irritability, further joint mobility testing of the shoulder girdle was deferred.

A hand-held dynamometer was utilized during resisted testing of the glenohumeral joint, which was performed in the positions as described by Cyriax.[17] The results of strength testing can be found in Table 1. Fieseler et al found high intra-rater reliability for the use of hand-held dynamometry on the shoulder with ICC values of 0.96-1.00.[18] Manual muscle testing of the lower and middle trapezius muscles was performed in prone, as described by Kendall.[19] The subject was unable to maintain any of the testing positions against gravity due to reports of global left shoulder pain. Thoracic mobility was assessed in prone via posterior-anterior joint mobilizations as described by Maitland et al,[20] and no segmental hypomobility or pain was noted. Heiderscheit et al found the intra-examiner reliability of joint mobility testing to have a kappa value between 0.61-0.80 when a global assessment was made across more than one spinal level, while the reliability of pain provocation assessment was considered very good with a kappa value between 0.81–1.00.[21]

Table 1. *Shoulder Complex Isometric Testing, using Hand Held Dynamometry.*

Motion	Left	Right
Shoulder Flexors	6lbs (with pain)	11lbs
Shoulder Internal Rotators	18lbs (with pain)	22lbs
Shoulder External Rotators	9lbs (with pain)	12lbs

While the subject presented with impairments that were appropriate for physical therapy treatment, no conclusive movement or pathological structural diagnosis had been made. Although initial cervical screening was inconclusive, further evaluation was performed with the subject in supine. In order to help the subject relax, gentle manual cervical traction was applied prior to assessing joint mobility. Upon applying the traction force, the subject reported an immediate reduction of pain from 6/10 to 1-2/10. The subject reported that this was the "best" his shoulder had felt within the past year, and his symptoms remained reduced after the traction force was released (4/10 after releasing manual traction). A similar response in symptoms was experienced with lateral glide assessment of the mid to lower cervical spine when mobilizing away from the involved extremity.

CLINICAL IMPRESSION #2

At this point in the evaluation, the examiner was able to make the following assessments:

- Persistent shoulder pain of an insidious onset for the past year with high irritability and severity (7/10 average NPRS)
- Reduction of shoulder pain occurred following both cervical traction and lateral glides from 6/10 to 1-2/10, despite full, symptom-free cervical AROM and a negative Spurling's test. Reasoning behind this response has been speculated previously, with hypothetical rationales including activation of descending pain inhibitory systems through joint mechanoreceptors, decreasing stress on neural tissue, and improving neural mobility.[22-24]
- Limitations in shoulder motion (both active and passive) with high pain severity/irritability
- Weakness and impaired motor control of scapular stabilizing musculature during visual observation
- Weakness of shoulder musculature, demonstrated via HHD results
- Altered sensation to light touch along C4 and C5 dermatomes
- Inability to participate in sports related activities including football, skeet shooting, and physical education class

The uniqueness of the pathological presentation was quite evident following the evaluation, and although no formal movement diagnosis was generated, the subject was deemed appropriate for physical therapy based on the number of impairments that could be addressed through conservative treatment (high pain severity/irritability, range of motion, strength, etc.). The initial plan for treatment included addressing irritability of symptoms through manual therapy techniques directed at the cervicobrachial region in the form of mid to lower cervical lateral glides and cervical traction, and neuromuscular retraining of the upper quarter musculature. Outcomes that would be assessed related to mobility, strength without pain, as well the DASH, PSFS and NPRS scores.

INTERVENTION AND OUTCOMES

Initial treatment included educating the subject on performing neuromuscular re-education of the longus colli muscle in supine, as well as performing standing scapular retractions. Both of these exercises were chosen initially due to movement impairments observed during shoulder active range of motion assessments, including inability to control scapular internal rotation and forward head positioning during overhead movements. While no formal assessment of deep neck flexor strength or endurance was completed during the initial examination, it has been shown that individuals with persistent neck pain have a reduction in the feedforward activation of the neck musculature during active shoulder motions.[25] That being said, there is limited evidence to support this treatment for the subject's overhead movement strategies, but addressing the motor coordination of the neck musculature appeared warranted.[26] In addition, scapular retraction exercises were utilized to assist in retraining the periscapular muscles in a pain free manner to address the aforementioned movement coordination impairment. To assist in symptom management, the subject's mother was instructed on how to perform manual cervical traction in supine to be utilized as needed.

At the subsequent therapy session, the subject reported that his symptoms remained reduced since the initial evaluation, although he reported a return of 6/10 discomfort after performing manual labor including lifting boxes earlier in the day. The subject stated that he was able to perform typical activities of daily living without a reproducing his shoulder pain, and that he tolerated the home exercises without any difficulties. Treatment focus remained on pain control and neuromuscular re-education. Once again, cervical traction and lateral glides were performed to decrease the subject's pain level, but the subject's left shoulder was positioned at progressively increased ranges of shoulder abduction (90, 100, 120 degrees respectively) to preload neural structures during the mobilization techniques.[23] The use of upper extremity pre-positioning with manual therapy to the cervical spine has been documented in previous cases for the treatment of cervical radiculopathies.[22,23] The subject was able to tolerate each incremental increase in shoulder motion, although

no reduction of symptoms at 120 º of abduction was noted.

After reducing the subject's symptoms to 2/10, the focus of the session shifted towards neuromuscular re-education. Manual resistance was provided to the subject s involved extremity in the form of rhythmic stabilization. Due to the subject's limited tolerance to activities above 90 degrees of shoulder flexion, stabilization was performed at approximately 30 degrees of flexion while in supine and tolerated well by the subject. The subject was also instructed in isometric shoulder extension in supine, as well as scapular push-ups against a table to promote serratus anterior activation.[27,28] Exercises were attempted in quadruped, but the subject reported increased shoulder pain with upper extremity weight bearing, and they were not continued. Pending the subject's progress with home exercises, the plan was to begin introducing progressive resistive exercises for scapular stabilizing and rotator cuff muscle groups. Moezy et al found that scapular stabilization exercises have been successful in improving shoulder range of motion, decreasing forward head and shoulder postures in subject s with subacromial impingement syndrome, and while this subject did not have a true impingement presentation, the impairments with which he presented may have benefit from this type of intervention.[26]

During the second follow-up appointment, the subject reported no increase in symptoms since the last therapy session (remained at a score of 2/10 on the pain scale). The subject also reported having an upcoming football combine within the next three weeks where he would be expected to perform exercises such as the bench press, back squat, and Farmer's walk, and was hoping to be able to participate. He was informed that these exercises would be introduced to his rehabilitation plan pending continued progress of his symptoms.

Due to the subject's minimal symptoms, no manual therapy was performed. A brief review of the subject's current home exercises was performed to ensure proper technique and execution. The following exercises were then performed and added to the subject's current home exercise plan (HEP): side lying external rotation, prone shoulder extension and with shoulder in external rotation, prone horizontal abduction with shoulder in external rotation, PNF pattern D2 shoulder flexion with a two-lb. dumbbell. Both the side lying external rotation and prone horizontal abduction with shoulder in external rotation have been shown to produce maximal muscle activity of the infraspinatus/teres minor and supraspinatus respectively.[29] The subject was provided with verbal and tactile cueing for technique, as well as to facilitate scapular retraction during the exercises. The subject attempted supine serratus anterior presses with a dumbbell, but due to the reproduction of symptoms, was provided with an upper extremity proprioceptive neuromuscular facilitation pattern (D2 flexion) with a dumbbell in standing as an alternative exercise.[30]

The subject returned to physical therapy for his third treatment session stating he had not required any manual traction to reduce his symptoms at home over the prior week, and that he had noticed improvements in shoulder range of motion. Upon measurement of gross shoulder motion, the subject was able to achieve 160 º of pain free shoulder flexion and shoulder abduction, without pain.

Once again, manual therapy techniques were withheld, and a dynamic warm-up including upper body ergometer was introduced. The subject's HEP was progressed to include performing a prone "Y" for continued lower trapezius recruitment, as well as a push-up with a plus for serratus anterior engagement and to promote weight bearing through the upper extremity. As the subject was preparing for the upcoming football combine, the subject was observed performing light bench pressing and Farmer's walks, both of which were pain free.

The fourth follow-up therapy session occurred one month after the initial examination, at which time a re-examination was performed in order to generate a progress note for the referring physician. The following objective measures from the re-examination are provided in Table 2.

The subject exhibited slight forward head posturing during active motion testing overhead, but a reduction of scapular dyskinesia was observed compared to the initial examination The subject also stated that he was able to complete the football combine and

Table 2. *Left Shoulder objective findings at initial examination and re-examination.*

Measurement	Initial Examination			Re-Examination		
AROM-Flexion	123º *			160 º		
AROM-Abduction	119 º painful			18 º pain free		
Strength of flexors	6lbs*			13lbs		
Strength of internal rotators	18lbs*			23lbs		
Strength of external rotators	9lbs*			12.7lbs		
Pain Score (0-10: least, average, worst)	Least	Average	Worst	Least	Average	Worst
	6	6	9	1	2	3
Patient Specific Functional Scale (basketball, skeet shooting)	Basketball	Skeet Shooting		Basketball	Skeet Shooting	
	5	6		10	10	
DASH (0= no disability,100 = fully disabled)	11.66			2.5		
DASH Sports Module (0= no disability,100 = fully disabled)	25			6.25		

*= pain with testing, AROM= active range of motion, DASH= Disabilities of the Arm, Shoulder, and Hand questionnaire

several workouts without pain, noting only muscular fatigue.

At this point in the rehabilitation plan (treatment sessions 6-8) focus was shifted towards more sports-specific activities with the intention of completing a return to play progression. Included within this phase were more dynamic activities (medicine ball tosses, chest press against BOSU, closed kinetic chain plyometrics), progressions of stabilization exercises (physioball walkouts with focus on scapular stabilization, Turkish Getups), and sports specific drills (stiff arm/hitting practice against a heavy punching bag, catching drills). The subject was cleared by the referring physician to return to sports without any restrictions, and as the subject was independent with his HEP and had reached goals of therapy, and therefore was discharged from skilled therapy services. The subject was provided with the DASH questionnaire upon discharge, in which he scored a 2.5 on the DASH and a 6.25 on the DASH sports module. Table 3 displays an outline of the treatment plan of care for this subject.

The subject was contacted eight months following discharge in order to check on his symptoms and function, at which time the subject had no reports of shoulder pain and was participating in baseball and skeet shooting without restrictions.

DISCUSSION

Although it is known that NOFs are typically asymptomatic bone lesions, there are several documented cases in which they result in pain.[1-3] As previously noted, there is little mention of the possible conservative treatments used with subject s with NOFs outside of a "wait and see" philosophy in which the lesion is simply observed.[1,2,6] While the NOF in this particular case may not have been the only contributing factor towards the subject's symptoms, it was an important component to take into consideration when establishing the treatment plan. The

Table 3. *Plan of Care Progression.*

Phase	Goals	Treatment

Phase One
 	
(Pain Control)
	• Pain Reduction
	• Cervicothoracic stabilization
	• Improve range of motion of glenohumeral joint
		Exercise
		• Supine longus colli neuromuscular re-education
		  ○ 10 reps x 10 sec, 2x/day
		• Seated Scapular Retraction (AROM)
		  ○ 10 reps x 5 sec, 2x/day
		• Isometric lower trap activation (supine)
		  ○ 10 reps x 5 sec, 2x/day
		• Serratus Push-ups Against Table (45 degree incline)
		  ○ 8-12 reps, 3 sets, 1x/day
		Manual therapies
		• Cervical Traction
		  ○ 20-30 seconds, 3-5 repetitions
		• Cervical Lateral Glides
		  ○ With and without UE pre-positioning
		  ○ Contralateral grade III mobilizations for 30 seconds, 3-5 reps
		• Glenohumeral Rhythmic Stabilization (supine)
		  ○ 30 degrees of shoulder flexion, 15-20 seconds, 3-5 reps

Phase Two
 	
(Strengthening)
	• Increase global scapulothoracic strength/endurance
	• Improve rotator cuff activation
	• Increase core stabilization
		Exercise
		• Upper Body Ergometer (Forward/Backward)
		  ○ 2 minutes each direction
		• Prone Shoulder Extension/Horizontal Abduction/Scaption
		  ○ 8-12 reps, 2-3 sets, 1x/day
		• Side Lying External Rotation
		  ○ 8-12 reps, 2-3 sets, 1x/day
		• Push Up-Plus
		  ○ 8-12 reps, 2-3 sets, 1x/day
		• Dumbbell Resisted D2 Shoulder Flexion
		  ○ 8-12 reps, 2-3 sets, 1x/day
		Manual
		• Glenohumeral Rhythmic Stabilization (supine)
		  ○ 90 degrees of shoulder flexion, 15-20 seconds, 3-5 reps

Phase Three
(Return to Play)
	• Improve dynamic stability of glenohumeral joint
	• Increase joint loading of glenohumeral joint
		Exercise
		• Physioball Walkouts
		  ○ 10 reps, 2 sets
		• Physioball Push Up Plus
		  ○ 8-12 reps, 2 sets
		• Turkish Get-Up (15 lbs.)
		  ○ 8 reps, 3 sets
		• Medicine Ball Toss against Rebounder (2-11 lbs.)
		  ○ 5-8 reps, 2 sets (chest pass, diagonal chops)
		• Dynamic Chest Press Against BOSU
		  ○ 5-8 reps, 3 sets
		• Closed Kinetic Chain Plyometrics
		  ○ Closed Kinetic Chain Upper Extremity Stability Tests
		  ▪ 15 seconds, 3 sets
		  ○ Plyometric Pushup
		  ▪ 5-8 reps, 3-5 sets
		• Football Catching Drills

Reps= repetitions, AROM= active range of motion

impairments discussed in this case, as well as their subsequent treatment plans, can be broken down into two primary areas of focus: the shoulder and the cervical spine. Since the subject was referred to physical therapy for shoulder pain, this was the initial focus during the physical assessment. Clinical examination revealed impairments that were appropriate for physical therapy rehabilitation, including pain, decreased range of motion, weakness of the shoulder complex musculature, impaired neuromuscular control, and decreased ability to participate in sports related activities. However, examination of the cervical spine revealed potential contributing factors including poor postural awareness, impaired neuromuscular control as demonstrated by forward head posturing with overhead motions, and suspected alterations in neuromechanical sensitivity evident through the effects of cervical traction and lateral glides on the subject's arm pain. Although formal upper limb neurodynamic testing was not performed, the subject presented with other factors several authors have described to be consistent with a neurogenic pain pattern, including high pain severity and irritability, burning and tingling symptoms throughout the upper arm, and pain generation without direct stimulus/response relationship.[31-35] Based on these impairments, it was hypothesized that by improving the neuromuscular control and stability of both the cervical and scapulohumeral regions, the potential irritation of the neural structures would lessen and allow for improved shoulder function. Due to the inconclusive physical therapy examination in ruling in or out a pathoanatomical source of the subject's symptoms, it was deduced that the aforementioned hypothesis was plausible based on the subject's positive outcomes from the initial interventions. A similar approach has been utilized when treating individuals with highly irritable adhesive capsulitis that present with signs of neural irritation, and upon addressing the underlying neuromechanical sensitivity, a significant improvement in shoulder function has been observed.[36]

While there were musculoskeletal impairments that were appropriate for physical therapy intervention, the dramatic, immediate improvement in symptoms with manual therapy at the cervical spine remains an interesting component to the plan of care. One possible explanation for the positive effects elicited by this treatment may be due to the mobilization of neural tissue. It has been suggested that mechanical cervical traction can both widen the intervertebral foramen and separate the vertebral bodies,[37] which would allow the surrounding neural structures to have less restriction to movement. Graham et al. also found that movements of the upper extremity have mobilized the cervical roots of the brachial plexus; therefore, it is hypothesized that movements of the cervical spine would cause resulting movements of the more peripheral neural structures of the plexus.[38] Based on this hypothetical assumption, the use of both cervical traction and lateral glides would assist in a form of neural mobilization at the nerve root.[39] Considering a recent systematic review that reported that studies investigating the effects of cervical lateral glide mobilizations consistently found significant improvements in pain in individuals with nerve-related neck and arm pain,[40] the manual techniques described in this case report could have resulted in the same effect. McClatchie et al. also found that mobilizations of the cervical spine in individuals without neck pain has been beneficial in reducing shoulder impairments, once again supporting the various manual techniques utilized in this case report.[41]

A questions remains: why would a subject with a NOF present with neurodynamic dysfunction? There are nociceptors within both the periosteum and marrow of bones, which would explain the possibility of having symptoms related to a NOF.[42] Sensitization of the dorsal horn neurons has been also documented as a potential source for referred pain or secondary hyperalgesia in individuals with bone pathologies, which may be more pertinent to the subject in this case report.[42] Considering the subject had hypoesthesia, reports of burning/tingling throughout the arm, and the chronicity of his symptoms, it would be reasonable to assume that alterations to the peripheral and/or central nervous system's processing had occurred, resulting in a sensitized state.[24,32] Central sensitization can cause the following changes to occur within the dorsal horn: spontaneous activity within the neurons, a decrease in the required stimulus to reach threshold, an augmented response once threshold is reached, an

increased receptive field size, and a range of neuroimmunologic responses, leading to enhanced central excitability and/or diminished central inhibition.[43-45] Central neuroimmunologic responses may lead to sensitize the dorsal root ganglia,[45] which in combination with aberrant movement patterns, could contribute to sensitization of the peripheral nerves of the upper quarter.[24,46] Based on the subject's presentation upon evaluation, it is plausible that his symptoms were due to a mix of peripheral and central pain mechanisms.[44] When taking into consideration the previous information regarding the benefits of neural mobilizations and the nociceptor innervation of the periosteum, mobilizing the cervical spine may prove beneficial in subject s with non-mechanical pain associated with NOFs. Further investigation of the conservative physical therapy management of individuals with radiological evidence of a NOF is needed to enhance the body of knowledge regarding this pathology.

LIMITATIONS

While the outcomes of this case report were positive, there are several limitations. For instance, the subject in this case presented with increased neuromechanical sensitivity, but this finding may not be consistent amongst other individuals. Having only a single subject within the case prevents generalizability to be made amongst all individuals with NOFs, and further investigation of the presentation and treatment of symptomatic NOFs remains warranted.

CONCLUSION

This case reports describes positive results after conservative treatment of a teenage athlete with a symptomatic NOF in the proximal humerus. He was able to return to full participation in his prior sports activities after a combined approach of manual therapy, neuromuscular re-education, and progressive resistance training. Physical therapists must take into consideration many factors that may be contributing to a subject's persistent pain. Alterations in neuromechanical sensitivity should be included as part of a differential diagnosis in subject s with persistent symptoms, particularly when there is evidence of a NOF. By incorporating neural mobilization techniques, along with addressing any pertinent underlying musculoskeletal impairments, utilization of conservative treatment options may be helpful in individuals with symptomatic NOFs.

REFERENCES

1. Glockenberg A, Sobel E, Noël JF. Nonossifying fibroma. Four cases and review of the literature. *J Am Podiatr Med Assoc*. 1997;87(2):66-9.
2. Bowers LM, Cohen DM, Bhattacharyya I, Pettigrew JC Jr, Stavropoulos MF. The non-ossifying fibroma: a case report and review of the literature. *Head Neck Pathol*. 2013;7(2):203-10.
3. Moretti VM, Slotcavage RL, Crawford EA, Lackman RD, Ogilvie CM. Curettage and graft alleviates athletic-limiting pain in benign lytic bone lesions. *Clin Orthop Relat Res*. 2011;469(1):283-8.
4. Hudson TM, Stiles RG, Monson DK. Fibrous lesions of bone. *Radiol Clin North Am*. 1993;31(2):279-97.
5. Abdelsayed RA, Sharma S, Ferguson H. Fibrous cortical defect (nonossifying fibroma) of the mandibular ramus: report of 2 cases. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2010;110(4):504-8.
6. Bailey JS, Nikitakis NG, Lopes M, Ord RA. Nonossifying fibroma of the mandible in a 6-year-old girl: a case report and review of the literature. *J Oral Maxillofac Surg*. 2001;59(7):815-8.
7. Shimal A, Davies AM, James SL, Grimer RJ. Fatigue-type stress fractures of the lower limb associated with fibrous cortical defects/non-ossifying fibromas in the skeletally immature. *Clin Radiol*. 2010;65(5):382-6.
8. Easley ME, Kneisl JS. Pathologic fractures through nonossifying fibromas: is prophylactic treatment warranted. *J Pediatr Orthop*. 1997;17:808–13.
9. Jensen MP, Miller L, Fisher LD. Assessment of pain during medical procedures: A comparison of three scales. *Clin J Pain*. 1998;14:343–349.
10. Jensen MP, Turner JA, Romano JM. What is the maximum number of levels needed in pain intensity measurement? *Pain*. 1994;58:387–392.
11. Price DD, McGrath PA, Rafii A, Buckingham B. The validation of visual analog scales as a ratio measure for chronic and experimental pain. *Pain*. 1983;17:45–56.
12. Childs JD, Piva SR, Fritz JM. Responsiveness of the numeric pain rating scale in patients with low back pain. *Spine*. 2005;10:1331–1334.
13. Cleland JA, Fritz JM, Whitman JM, Palmer JA. The reliability and construct validity of the Neck Disability Index and Patient Specific Functional Scale in patients with cervical radiculopathy. *Spine*. 2006;31:598–602.

14. Roy JS, Macdermid JC, Woodhouse LJ. Measuring shoulder function: A systematic review of four questionnaires. *Arthritis Care Res*. 2009;61(5):623-32.
15. Cleland JA, Childs JD, Fritz JM, Whitman JM. Interrater reliability of the history and physical examination in patients with mechanical neck pain. *Arch Phys Med Rehabil*. 2006;87:1388-1395.
16. Hegedus EJ, Goode A, Campbell S, et al. Physical examination tests of the shoulder: a systematic review with meta-analysis of individual tests. *Br J Sports Med*. 2007;42(2):80-92.
17. Cyriax J. *Textbook of Orthopaedic Medicine Volume I. Diagnosis of Soft Tissue Lesions.* London, UK: BalliereTindall; 1982.
18. Fieseler G, Molitor T, Irlenbusch L, Delank KS, Laudner KG, Hermassi S, Schwesig R. Intrarater reliability of goniometry and hand-held dynamometry for shoulder and elbow examinations in female team handball athletes and asymptomatic volunteers. *Arch Orthop Trauma Surg*. 2015;135(12):1719-26.
19. Hegedus EJ, Goode A, Campbell S, et al. Physical examination tests of the shoulder: a systematic review with meta-analysis of individual tests. *Br J Sports Med*. 2007;42(2):80-92.
20. Kendall FP, McCreary EK, Provance, et al. *Muscles: Testing and function with posture and pain. 5th ed.* Baltimore: Lippincott Williams and Wilkins; 2005. Pp. 329-30
21. Maitland G, Hengeveld E, Banks K, English K. *Maitland's vertebral manipulation.* Woburn, MA: Reed Educational and Professional Publishing, Ltd.; 2001.
22. Heiderscheit B, Boissonnault W. Reliability of joint mobility and pain assessment of the thoracic spine and rib cage in asymptomatic individuals. *J Man Manip Ther*. 2008;16(4):210-216.
23. Coppieters MW, Stappaerts KH, Wouters LL, Janssens K. The immediate effects of a cervical lateral glide treatment technique in patients with neurogenic cervicobrachial pain. *J Orthop Sports Phys Ther*. 2003;33(7):369-78.
24. McClatchie L, Laprade J, Martin S, Jaglal SB, Richardson D, Agur A. Mobilizations of the asymptomatic cervical spine can reduce signs of shoulder dysfunction in adults. *Man Ther*. 2009;14(4):369-74.
25. Butler DS. *The Sensitive Nervous System*. Unley, South Australia: NoiGroup Publications; 2000.
26. Falla D, Jull G, Hodges PW. Feedforward activity of the cervical flexor muscles during voluntary arm movements is delayed in chronic neck pain. *Exp Brain Res*. 2004 ;157(1):43-8.
27. Moezy A, Sepehrifar S, Solaymani Dodaran M. The effects of scapular stabilization based exercise therapy on pain, posture, flexibility and shoulder mobility in patients with shoulder impingement syndrome: a controlled randomized clinical trial. *Med J Islamic Repub Iran*. 2014;28:87.
28. Seo S-H, Jeon I-H, Cho Y-H, Lee H-G, Hwang Y-T, Jang J-H. Surface EMG during the push-up plus exercise on a stable support or swiss ball: scapular stabilizer muscle exercise. *J Phys Ther Sci.* 2013;25(7):833-837.
29. Pirauá AL, Pitangui AC, Silva JP, Pereira dos Passos MH, Alves de Oliveira VM, Batista Lda S, Cappato de Araújo R. Electromyographic analysis of the serratus anterior and trapezius muscles during push-ups on stable and unstable bases in subjects with scapular dyskinesis. *J Electromyogr Kinesiol*. 2014; 24(5):675-81.
30. Reinold MM, Wilk KE, Fleisig GS, Zheng N, Barrentine SW, Chmielewski T, Cody RC, Jameson GG, Andrews JR. Electromyographic analysis of the rotator cuff and deltoid musculature during common shoulder external rotation exercises. *J Orthop Sports Phys Ther.* 2004;34(7):385-94.
31. Witt D, Talbott N, Kotowski S. Electromyographic activity of scapular muscles during diagonal patterns using elastic resistance and free weights. *Int J Sports Phys Ther*. 2011;6(4):322-332.
32. Smart KM, Blake C, Staines A, Doody C. Clinical indicators of 'nociceptive', 'peripheral neuropathic' and 'central' mechanisms of musculoskeletal pain. A Delphi survey of expert clinicians. *Man Ther.* 2010;15(1):80-7.
33. Elvey RL, Hall TM. *Neural tissue evaluation and treatment in Physical Therapy of the Shoulder*, New York, NY: Churchill Livingstone; 1997.
34. Schafer A, Hall T, Briffa K. Classification of low-back related leg pain: a proposed patho-mechanism-based approach. *Man Ther*. 2009; 14:222-130.
35. Moloney, N., et al., The clinical utility of pain classification in non-specific arm pain. *Man Ther*. 2015; 20(1): p. 157-65.
36. R.J. Nee, D. Butler. Management of peripheral neuropathic pain: integrating neurobiology, neurodynamics, and clinical evidence. *Phys Ther Sport*. 2006; 7:36-49.
37. Farrell K, Lampe K. Addressing neurodynamic irritability in a patient with adhesive capsulitis: a case report. *J Man Manip Ther*. 2017; 25(1):47-56.
38. Graham N, Gross AR, Goldsmith C; Cervical overview group. Mechanical traction for mechanical neck disorders: a systematic review. *J Rehabil Med*. 2006;38(3):145-52.

39. Elvey RL. Treatment of arm pain associated with abnormal brachial plexus tension. *Aust J Physiother*. 1986;32(4):225-30.
40. Ellis RF, Hing WA. Neural Mobilization: A systematic review of randomized controlled trials with an analysis of therapeutic efficacy. *J Man Manip Ther.* 2008;16(1):8-22.
41. Basson A, Olivier B, Ellis R, Coppieters M, Stewart A, Mudzi W. The effectiveness of neural mobilization for neuromusculoskeletal conditions: a systematic review and meta-analysis. *J Orthop Sports Phys Ther.* 2017;47(9):593-615.
42. McClatchie L, Laprade J, Martin S, Jaglal SB, Richardson D, Agur A. Mobilizations of the asymptomatic cervical spine can reduce signs of shoulder dysfunction in adults. *Man Ther.* 2009;14(4):369-74.
43. Nencini S, Ivanusic JJ. The physiology of bone pain. How much do we really know? *Front Physiol*. 2016;7:157.
44. Latremoliere A, Woolf CJ. Central sensitization: a generator of pain hypersensitivity by central neural plasticity. *J Pain* 2009;10(9):895-926.
45. Chimenti RL, Frey-Law LA, Sluka KA. A mechanism-based approach to physical therapist management of pain. *Phys Ther*. 2018; 98(5):302-314.
46. Winkelstein BA. Mechanisms of central sensitization, neuroimmunology & injury biomechanics in persistent pain: implications for musculoskeletal disorders. *J Electromyogr Kinesiol*. 2004;14(1):87-93.
47. Shacklock MO. *Clinical Neurodynamics: A New System of Musculoskeletal Treatment.* Sydney, Australia: Elsevier Butterworth-Heinemann; 2005.